Arizona Geological Society Newsletter

DECEMBER 2018

December 4th, 2018 DINNER MEETING

Who: **David (Duff) Gold** is the featured speaker. See abstract below.

Where: Sheraton Tucson Hotel and Suites, 5151 East Grant Road, (at the intersection of Grant and Rosemont on the North side of Grant in the **SABINO BALLROOM** (enter at northwest corner of the building) and go upstairs to the meeting room.

When: Cash Bar at 6 p.m.—Dinner at 7 p.m.—Talk at 8 p.m.

Cost: Members $30, Guests $33, Students Members free with online reservation ($10 without).

RESERVATIONS ARE REQUIRED: Reserve on the AGS website (http://www.arizonageologicalsoc.org/events) by 11 am on Friday, November 30th. Please indicate Regular (Braised Top Sirloin with Brown Sugar Bourbon Glaze), Vegetarian (Four Cheese Ravioli with Basil and Garlic Cream Sauce), or Salad (Greek Salad with Chicken) meal preference. Please cancel by **Friday, November 30th at 11 am** if you are unable to attend - no shows and late cancellations will be invoiced.

The December dinner meeting is sponsored by

If you are interested in sponsoring a dinner meeting, please email:
vpmarketing@arizonageologicalsoc.org

ABSTRACT

Deep-Seated Volcanism and the Genesis of Diamonds

**by David (Duff) Gold, Emeritus Professor of Geology,
Dept of Geosciences, Pennsylvania State University**

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Kimberlites (senso lato) are OH-rich ultramafic (silica deficient) rocks with a porphyritic texture that may contain phenocrysts and xenocrysts of pyrope-rich garnets, magnesian-rich ilmenite (picro-ilmenite), chrome-diopside, spinels, phlogopite and diamonds, as well as foreign inclusions (xenoliths) of exotic olivine-pyroxene-garnet-spinel assemblages. Evolved varieties include phlogopite-rich (Type II) and the highly potassic lamproites that may contain sanidine, feldspathoids (leucite) and unusual K-rich amphiboles (K-richterite), and a host of barium and titanium rich minerals (priderite, perovskite, wadeite). They occur in fissures or thin dikes and as "blow-outs" in carrot-shaped "diatreme breccia pipes", too far from the source to be "normal" quenched magma melts. Consistent with their high fluid content, outgassing took place at great depth, and emplacement was achieved rapidly along hydraulically driven cracks from depths of the order of 50 to more than 150 kms. Diatremes are essentially, near surface structures, with both crater and vent facies preserved. No lava except for some lamproites has been verified. Outgassing fluids, with modeled velocities as high as Mach 2, plucked, entrained, rounded, polished and mixed samples of the upper mantle and lower crustal rocks, up to 60 cm across, with more angular upper crustal lithologies, and polished the walls of some of the diatreme vents. "Kimberlites" were emplaced periodically throughout geologic time with a peak during Cretaceous times (disruption of Gondowanaland). The predominance of lamproites to the Tertiary may reflect erosion depth rather than temporal distribution.

Although kimberlite-type volcanism is more common than once suspected, kimberlitic intrusions are volumetrically small, and tend to be clustered. Some kimberlite and lamproites are of interest economically as a primary source of diamonds, albeit as the dispersant rather than the concentrating agent. Of more than 9000 known kimberlitic bodies only approximately 5% contain diamonds (mainly as "micros", <0.5 mm) and less than 10% of these are likely to be economic.

Traditional exploration sought to find kimberlite intrusions by sampling of stream sediments for a characteristic suite of heavy minerals (picro-ilmenite, Cr-diopside and low Ca –Cr-rich garnets), referred to as "indicator" (or "sputnik" minerals). Lamprophyres have a different "sputnik" assemblages. Although the ultimate test for economic viability of a kimberlite/lamproite body is "production performance", much of the guesswork is reduced by improved sampling strategies, and correlated geochemical/mineralogical parameters of the more abundant xenoliths and xenocrysts in the host. These include, amongst others, the partitioning between elements (such as alumina and chrome between coexisting minerals such as garnets and pyroxenes) adjacent to and within diamonds that yield information of pressure and temperature in the source region in the upper mantle. Other favorable factors include the presence of (a) G-9 and G-10 garnets (low Ca, high Cr pyrope), (b) the absence of an oxidation trend (overgrowths) in the ilmenites and spinels. Additional evaluation is warranted if the P-T regime, inferred from co-existing sets of minerals in the xenoliths, plot in a fertile region defined by the diamond/graphite inversion boundary and geothermal gradient.

Experimental work on carbon indicate an environment of 1300°C and 54 kbars (<4 GP pressure) for diamond growth from a melt: conditions likely to occur only beneath old cold cratons. Arizona has its share of these diatremes in the northeastern part of the state and adjacent areas in Utah, Colorado and New Mexico. These "Colorado Plateau" diatremes differ from typical kimberlites in the abundance of unaltered ultramafic nodules, "fresh" olivines, and a paucity of serpentinization and absence of G9 or G10 garnets. Conventional wisdom is that the mantle is too hot at the right depth. However, diamond have been produced from Murfreesboro (Prairie Lake) in Arkansas, and Kelsey Lake in northern Colorado, but neither are considered economically viable.

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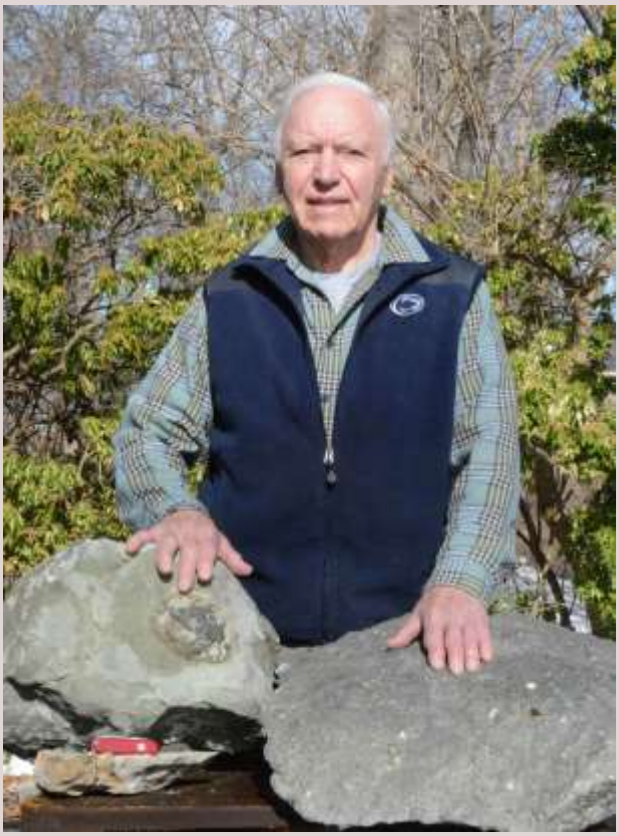
Diamonds are classified geologically as "p-type" for peridotitic from "fertile" asthenospheric (pristine) mantle, or "e-type" for eclogitic from a depleted or lithospheric (recycled) mantle. Different types of diamonds may represent stages and storage of Earth's carbon from crust to core. The recent discovery of Ice-7 in a diamond suggests a complex history. Diamond have been around since the early crust of the earth formed and they probably record a dynamic earth history until the time of emplacement (some more than a billion years later). Modern exploration focuses on extensional settings in "OLD COLD CRATONS". The marketing of synthetic diamond gemstones earlier this year is significant because it may spur the development of doped diamond crystals for "quantum' processors.

ABOUT THE SPEAKER



David Percy Gold was born (June, 1933) in Natal, South Africa, the great-grandson of immigrants from Brecken, Scotland, and grew up in a rural farming community. After matriculating from Maritzburg College (1950), he completed three degree (B.Sc., B.Sc. (Hons) and M.Sc.) in geology from the University of Natal, South Africa. He spent two years as an Assistant Geologist (Union Corporation) in the Witwatersrand Gold Fields, before starting graduate studies at McGill University, Montreal, Canada. His thesis on the evolution and emplacement mechanism of rare carbonate-bearing rocks with deep-seated roots in the upper mantle, complemented his early interest in the nature of kimberlites. He married Jacqueline Kebble (from Springs, South Africa) in Montreal on October 9, 1959. They migrated to State College, Pennsylvania in 1964, where they raised and educated four children.

A lecturer post at Loyola College in Montreal, enabled him to spend summers with the Dominion Observatory (Ottawa) on a Program to examine the origin for "large circular features" on the Canadian Shield, and determine which might be astroblemes (meteorite impact sites). A post-doctoral fellowship at Penn State (1964), under the tutelage of O.F. Tuttle, and P.J. Wiley, melded both these interests in a NASA-sponsored project to develop criteria for distinguishing exo- from endo-genic terrestrial craters (part of the Gemini and later Apollo space programs). He has presented more than 50 articles on these topics. Interaction with Frank Dachille (Penn State) fostered his thinking on the scale of geological processes involving short time-spans, large features, and enormous amounts of energy – a topic he continues to develop.

He has conducted detailed field mapping projects in Africa, Canada, and the United States, and visited mining sites in central and South America, India and Russia. Current studies on kimberlites focus on the anomalous emplacement habits of dikes exposed underground in some Pennsylvania coal mines.

A t Penn State, he taught courses in Economic Geology, Geology for Mining Engineers, Structural Geology, Remote Sensing and Photo-geology, Field Methods and Field School, from the mid-60's to the mid-90's. Extra-curricular activities included short courses for National Science Foundation, National Groundwater Association, U.S. Army Corp of Engineers and PetroChina. He served on the MLA-MRE Advisory Group (NASA) on Remote Sensing and Space Technology during the 1980's. He is a Fellow of the Geological

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Society of America and the Geological Association of Canada. His kudos include the Barlow Memorial medal from the Canadian Institute of Mining and Metallurgy/Geological Association of Canada (1967), the Wilson Outstanding Teacher medal (1971) from Penn State, the 24th International Geological Congress, Presidents medal, 1972. He was one of the American Geological Institute's Distinguished Lecturers for 1971.

His association with Penn State started as a post-doctoral fellow at Penn State during the fall of 1964. This appointment morphed into Research Associate status in 1966, a tenured faculty position in 1968 and a professorship in 1975. He was Director of the Penn State Field School (1971-97), Chairman of the Geology Graduate Program from 1977-1982, and the University Ombudsman (1997-2011). He considered Field School, operating out of Red Lodge, Montana, and Alta, Utah, as his Summer vacation. Although he formally retired end of 1997, he was awarded emeritus status at Penn State and maintains an office in Deike Building.

Don't forget this is our last dinner meeting of the year — feel free to attend in holiday finery!
(Ugly sweaters are also welcome!)

Arizona Geological Society Membership Stats (11/28/2018)

Total Membership	Professional Members	Student Members	Organizational Members
403	339	57	7

Please welcome our new members!

Rasheede Almogaty

Brody Rastall

Gabor Toth

Arizona Geological Society is pleased to announce the scholarship recipients for 2018!

2018 M. Lee Allison Scholarship Recipient

Lorraine Carnes

Lorraine "Lorrie" Carnes received a B.S. in Geology from Lehigh University in Bethlehem, Pennsylvania in the spring of 2017. She was awarded a Presidential Scholarship to attend Lehigh tuition-free for a fifth year, allowing her to complete an Honor's thesis, and was inducted into Phi Beta Kappa (2015) and Sigma Xi (2017). Currently in her second year in the School of Earth and Space Exploration at Arizona State University, Lorrie anticipates earning a PhD in Geological Sciences in the spring of 2022. Prior to arriving at ASU, she was awarded a competitive and prestigious multi-year NSF Graduate Student Research Fellowship and after her first year she received an ASU Graduate Excellence Award.

Lorrie's community involvement is extensive and tends toward educational undertakings. As an undergraduate, she partnered with the Lehigh Community Service Office to lead environmentally themed alternative, outdoor-oriented spring-break trips. At ASU, she mentors younger students and serves on the Open House Committee and the Women in Science Program. Also, as a founding member of ASU's prison education program, she is active in developing geology and astronomy course for inmates.

Lorrie's scientific interests are wide-ranging within the realm of quantitative geomorphology and landscape evolution. Her undertakings include the study of meandering river response to base-level fall and, for her dissertation, understanding the role and chronology of externally driven vs. internally driven geomorphic processes in the evolution of the Sky Island topography of southeast Arizona.

Lorrie will be presented with the Allison Scholarship award at the Society's December 4, 2018 dinner meeting.

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2018 J. Harold Courtright Scholarship Recipient

Alexandra Leigh Wallenberg

Alexandra "Lexi" Wallenberg received a B.S. in Geology from Illinois State University in Normal, Illinois in the spring of 2018. In the summer following graduation, she completed a research internship at the U.S. Geological Survey in Denver. When she arrived in the Department of Geosciences at the University of Arizona in the fall, Lexi completed the 10-day Ore Deposit Mapping short course offered by the Lowell Program in Economic Geology and will participate in the 10-day December 2018 Short Course on Cu, Mo, and Au Porphyry Deposits. Currently in her first year at UA, she anticipates earning a Masters degree in Geology.

Lexi's thesis area is in the Sonoma Range of Nevada, where she is studying magmatism and porphyry-style alteration and mineralization of the Gregg Canyon intrusive center and its hydrothermal aureole. Her research advisor is Eric Seedorff.

Lexi will receive the Courtright Scholarship award at the Society's December 4, 2018 dinner meeting.

A big congratulations to our scholarship recipients, and we are excited to meet you at the December 4th dinner meeting!

CALL FOR VOLUNTEERS to form STAFF-STEERING COMMITTEES for Geological Society of America 2019 Conference

In Sept. 2019, the Geological Society of America (GSA) brings its annual conference to Phoenix. This is a once in a generation opportunity for AGS to perform on a national platform; GSA's annual conference was last convened in Phoenix in the mid-1980s. The AGS Executive Committee is strategizing a role for AGS at the fall 2019 meeting. AGS involvement is consistent with the role and responsibilities laid out on our website - The Arizona Geological Society promotes and encourages interest in the science of geology ... A subset of Executive Committee members met Thurs., 5 Oct., and identified four areas for AGS involvement. Our next step is to form sub-committees to address those areas, and we sorely need the active involvement of AGS members. The AGS Executive Committee simply cannot carry this off without member support.

Field Trip(s): 2019 AGS VP of Field Trips, Wolf Schuh, will direct this committee which is charged with identifying and organizing one or more field trips as part of the GSA Field Trip program. Arizona State Geologist and AGS member Phil Pearthree chairs the GSA Field Trip effort.

Technical Session(s): This committee is charged with planning one or more technical sessions showcasing the geology, economic geology, and/or tectonic setting of Arizona. ASU geoscientist and AGS member Steve Semken is chairing the GSA program and we are confident he will enthusiastically support AGS efforts here.

* If you have ideas for the topic for a technical session, please send us a note with description.

State Geological Societies ice breaker: 2019 AGS Treasurer Mike Conway will direct a committee to explore organizing and promoting an evening ice breaker/ ad hoc discussion for the officers and members of geological societies to informally address the role and challenges of geological societies going forward.

AGS booth on the Exhibit floor: This committee would explore the cost and efficacy of co-hosting an exhibit booth with our colleagues from the Utah, Nevada, and New Mexico geological societies.

There may be other areas of involvement for AGS. We welcome your ideas and your input.

Next Steps:

The clock is ticking on submitting field trips and technical sessions. We need AGS members to step forward and staff these subcommittees posthaste.This is the time for AGS members to step forward on behalf of Arizona's Earth science community to showcase Arizona's magnificent geology. Your support of Arizona's geoscience community is crucial, so please contact one of the following at your earliest convenience.

Please let us know if you have questions or concerns.

Respectfully,

Mike Conway (fmconway@email.arizona.edu<mailto:fmconway@email.arizona.edu>); Karen Wenrich (crystalsul@aol.com<mailto:crystalsul@aol.com>); Leandra Marshall (leaxsmars@gmail.com<mailto:leaxsmars@gmail.com>)

Arizona's Broadband Seismic Network (ABSN) finally has statewide coverage

by Jeri Young Ben-Horin (AZGS Research Scientist)

The Arizona Geological Survey's broadband seismic network (ABSN) has reached a significant milestone. For the first time ever, multiple seismic stations are in place and provide a statewide seismic monitoring network that can be used to estimate seismicity rates, the amount of ground-shaking and can provide seismic data that can be used to image subsurface processes. Many people in Arizona do not know that Arizona experiences earthquakes and that although infrequent, damaging earthquakes do occur (Map of earthquakes and active faults).

Within the past year the AZGS has more than doubled the size of the statewide seismic network with the addition of 6 broadband stations installed by the end of 2017, and the recent adoption of two stations from the Earthscope Transportable Array project. The AZGS now operates and maintains 15 broadband seismic stations, and together with two other stations operated by the United States Geological Survey, there are a total of 17 broadband seismic stations throughout the state. These stations continually provide waveform data for local, regional and global quakes, and nuclear explosions. The data are continually archived at a international data management center operated by the Incorporated Research Institutions for Seismology (IRIS).

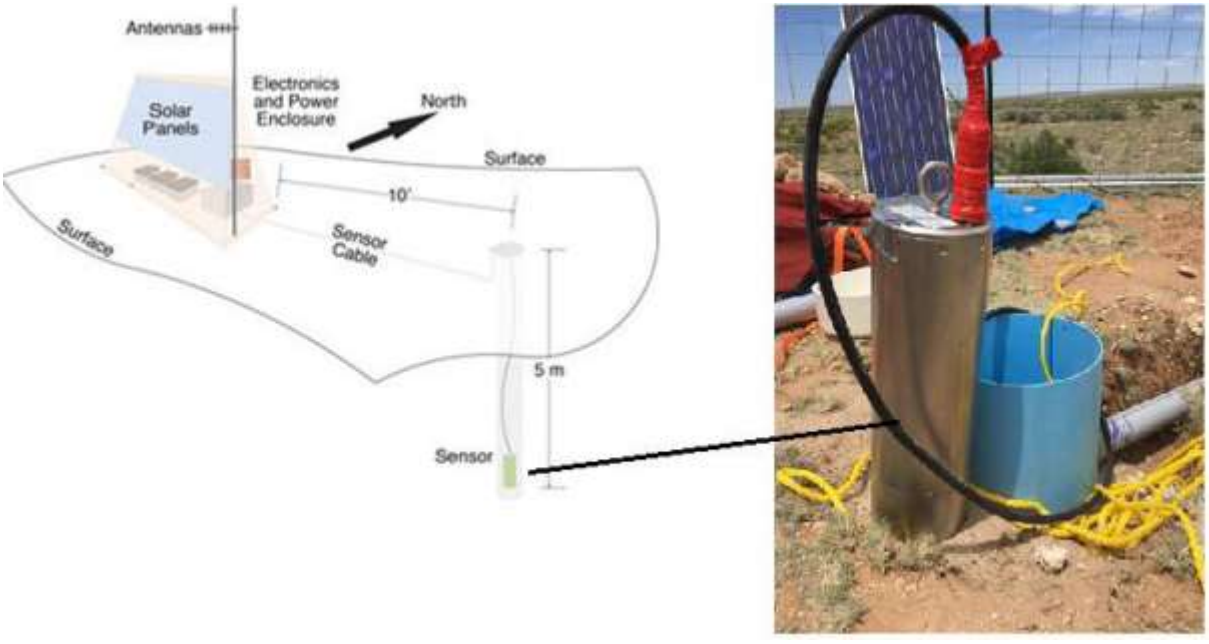

Figure 1. Map of Arizona with location of earthquakes (shown as circles) and active faults (shown as lines of green, orange and purple). AZGS seismic station location shown as red triangles. USGS/GSN stations shown as blue triangles. The majority of recorded earthquakes have occurred mostly in the northern half of the state. Large quakes originating in California, Mexico, as well as Utah and Nevada have caused significant ground-shaking within Arizona.

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The AZGS is updating the computing systems that take in the real-time seismic signals so that they can be used to detect earthquakes in the lower magnitude range (less than M3.0). The current system can detect quakes down to M3.0 for a good portion of the state, but AZGS' goal is to detect all earthquakes within the state down to M3.0. For areas with higher populations, and seismic activity, the goal is a detection threshold of M2.5.

The original Arizona Geology e-Magazine article by AZGS can be viewed here:

http://blog.azgs.arizona.edu/blog/2018-11/arizonas-broadband-seismic-network-absn-finally-has-statewide-coverage

Please contact the AGS Secretary if your company is interested in advertising in this monthly newsletter.

Arizona Geological Society is grateful to Freeport-McMoRan, Inc. for their generous support of our student members!

Freeport-McMoRan sponsored student dinners for the 2018 AGS monthly meetings.

FREEPORT-McMoRAN

AGS MEMBERSHIP APPLICATION OR RENEWAL FORM

YOU CAN RENEW OR SIGN UP as a new member and pay online. Please go to our website, arizonageological soc.org. Or use the form below if you are more comfortable with the old school approach.

Please mail check with membership form to: Arizona Geological Society, PO Box 40952, Tucson, AZ 85717

Dues (check box) ☐ 1 year: $35; ☐ full-time student (membership is free)

NEW MEMBER or RENEWAL? (circle one) Date of submittal _____

Name: _____ Position: _____

Company: _____

Mailing Address: _____

Street: _____ City: _____ State: _____ Zip Code: _____

Work Phone: _____ Home Phone: _____

Fax Number: _____ Cellular Phone: _____

E-mail: _____ Check this box if you do not have an email address ☐

All newsletters will be sent by email. If you do not have an email address, we will mail a hard copy to you, but we cannot guarantee timeliness.

If registered geologist/engineer, indicate registration number and State: _____

Enclosed is a _____ tax-deductible contribution to the ☐ J. Harold Courtright or the ☐ M. Lee Allison Scholarship Funds.